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ABSTRACT

The Learning in Science Project (Primary)--LISP(P)--investigated the ideas and interests children have about flowering plants (in particular whether these plants have a life cycle). Data were obtained from: individual interviews with children, ages 7- to 14-year-old (10 students for each age level), using the "interview-about-instances" (IAI) procedure; a survey of 351 students to establish the prevalence of ideas that emerged during the interviews; and whole-class sessions to elicit questions children have about flowering plants. Results are presented, analyzed, and discussed in separate sections representing students' views about: the instances and non-instances of flowering plants; the functions of flowers, fruit, and seeds; and the reproduction of certain plants. A separate section is devoted to other ideas (such as all plants having seeds) expressed during interviews. One finding noted is that only 4 students (out of the 80 interviewed) had an idea of the flowering plant life cycle similar to that of a biologist's view. Implications for science instruction, based on this and other findings, are discussed, such as providing experiences for students to see different plants in flower, fruit, and seed stages. (IAI cards, the classroom survey questionnaire, and initiating strategies to elicit students' questions about flowering plants are included in appendices.) (JN)

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LEARNING IN SCIENCE PROJECT (PRIMARY)

PUPILS' IDEAS ABOUT FLOWERING PLANTS

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Working Paper No. 125

PUPILS' IDEAS ABOUT FLOWERING PLANTS

Fred Biddulph

October 1984

Learning in Science Project (Primary) Working Paper No. 125

INTRODUCTION

In an earlier investigation into pupils' meanings for the word 'plant', Bell (1981) found that children tended to consider living matter to be a plant if it had flowers, but that some children thought that vegetables such as carrots, and non-cultivated things such as weeds and grasses, were not plants.

Given that flowering plants is a topic that meets the criteria for primary science proposed by Harlen and Osborne (1983), it seemed useful to extend Bell's work to investigate pupils' ideas about flowering plants, and in particular whether they understand generally that flowering plants have a life cycle. This paper reports on an investigation undertaken for this purpose. Implications for teaching which could be incorporated in a teacher guide booklet to supplement existing resource units are drawn from the results.

THE INVESTIGATION

The investigation took three main forms, namely individual interviews to obtain pupils' ideas and questions about flowering plants, a survey to establish the prevalence of particular ideas that emerged during the interviews, and whole class sessions to elicit questions children have about flowering plants.

1. The interviews

Ten pupils at each age level 7-14 years (a total of 80 pupils) were interviewed individually using coloured photographs. The first photograph (see Appendix A), which showed flowers on several plants, was used to establish with each pupil first that some plants can have parts which are called 'flowers'. The interviewer pointed to the flowers and asked, "What would you call these?" Without hesitation, each child answered, "Flowers". The interviewer then proceeded with the main part of the interview using the other coloured photographs (see Appendix B) which depicted instances and non-instances of flowering plants.

Since it was not possible to obtain photographs showing flowers, fruit and seed of each of the instances a decision was made to use photographs which showed the plants but no flowers, fruit or seeds. The pupils would therefore have to draw on their own experience in responding to the items. This was considered appropriate since any views that they presently held about the life cycle of flowering plants would be based on that experience. It was felt that this approach would lessen the possibility of pupils constructing ideas in the interview based on the items observed.

Each interview was recorded on audio-tape, and later transcribed and analysed.

Taking the first photograph of the series, the pupils were told, "This is part of an apple tree." (With subsequent photographs, pupils were told, for example, "This is some long grass." "These are some carrot plants." "This is a gorse bush.")

Then the pupils were asked, with respect to each photograph in turn,
"Can an apple tree (or whatever the photograph depicted) have flowers on?"
"Can a ..... have fruit on?"
"Can a ..... have seeds anywhere?"
and their responses were recorded on a record form (see Appendix C) in front of them. The responses of a number of children were probed further with supplementary questions such as:
"How did you know about that?"
"Where would the seeds actually be on the ......?"
"What do you call the ..... (pumpkin, tomato, bean)?"

Next the interviewer inspected the pupils' responses on the record form and addressed the pupil, "You said that the (e.g. apple tree) and the (e.g. rose bush and so on) can have flowers on. I wonder why these do have flowers." The same procedure was used to elicit the pupils' ideas about the function of fruit and seeds. Where it seemed to the interviewer that a pupil was having difficulty responding to this form of probe into his/her idea of the function of flowers and fruit, the following supplementary question was put, "Would the flowers (or fruit) be of any use to these things that you said they were on?"

At the end of the interview each pupil was invited to ask questions about any aspect that was puzzling or any aspect s/he would like to know about.

2. The survey

The survey (see Appendix D) was administered to a total of 351 pupils as shown in Table 1.

Table 1: Pupils surveyed about the function of seeds, fruit and flowers

AGE LEVEL	ABILITY LEVEL	NUMBER OF PUPILS
7- 8 yr	Mixed	74
9-10 yr	Mixed	173
11-12 yr	Average-above average	104

The pupils were told by the researcher that an apple tree, for example, can have fruit (the apples), that it can have seeds or pips in the apples, and that it can have flowers on (also called blossom). The researcher then took the pupils through the survey one section at a time by reading the range of possible responses in turn and inviting the pupils to mark with a tick the response that most closely matched their idea. The last two items in each section were dealt with separately. Thus in the first section about 'seeds' the pupils were asked to indicate which of the first four items most closely matched their idea. They were then asked to tick No. 5 if they didn't really know why a plant or apple tree has seeds - even though they may have ticked one of the first four items - and to tick No. 6 if they had never thought about it before.

3. The class sessions to obtain questions

Four classes of pupils at the 8-10 year age level were provided with initiating experiences (see Appendix E) and their subsequent questions about flowering plants were recorded.

THE SCIENTIFIC VIEW OF FLOWERING PLANTS: PLACE, STRUCTURE, FUNCTION

1. Flowering plants as a subset of plants

The place of flowering plants within the plant kingdom is shown in Figure 1.

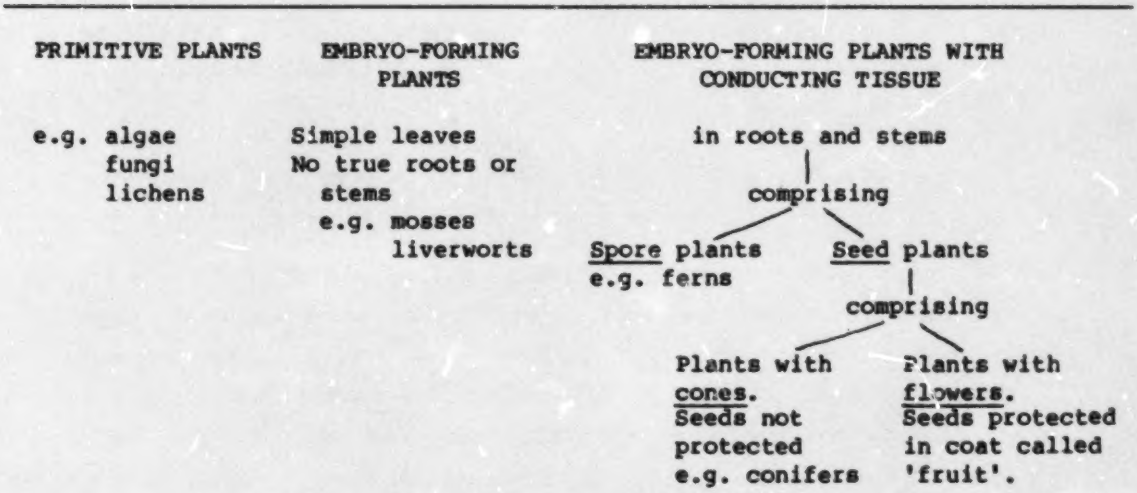

Figure 1: The place of flowering plants within the plant kingdom

Many of the plants which children encounter in their everyday lives are in fact flowering plants. These include grasses, a number of vegetables, and many of the weeds and trees. It will be seen from Figure 1 that two of the interview items (fern and mushroom) are non-instances of flowering plants.

2. The structures, flowers, fruit and seeds

(a) Flowers

The floral part of a plant generally consists of petals, sepals, stamen, carpel and receptacle as shown in Figure 2.

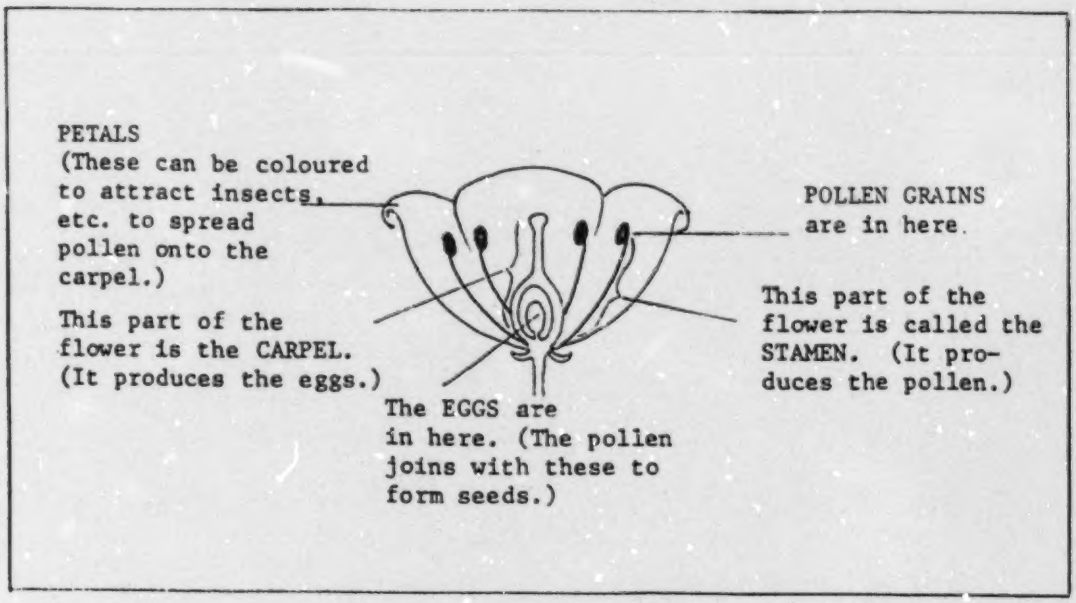
PETALS
(These can be coloured to attract insects, etc. to spread pollen onto the carpel.)
This part of the flower is the CARPEL. (It produces the eggs.)
POLLEN GRAINS are in here.
This part of the flower is called the STAMEN. (It produces the pollen.)
The EGGS are in here. (The pollen joins with these to form seeds.)

Figure 2: Flower structure

However, there is considerable variety among flowers. On some plants, for example, the flowers have no sepals, while on others there are separate male and female flowers which contain no carpel and stamen respectively.

(b) Fruit

Fruit is the enlarged ovary wall of the flower which usually contains one or more seeds. The outside of the fruit may be relatively hard (as with a pumpkin or walnut) or it may be fleshy (as with an apple, tomato or bean).

Thus a number of foods commonly called vegetables are also fruits in the scientific sense (e.g. tomato, bean, capsicum, sugar peas, corn, cucumber, pumpkin), as are rose hips, the pods on gorse and the small cases enclosing the seeds of grass and carrot plants.

(c) Seeds

A seed is the fertilized ovule or egg cell which develops inside the ovary of the flower. It consists of a seed coat, an embryo (a tiny young plant with embryonic roots, stem and leaves), and a food supply to eventually enable the young plant to grow until its leaves are sufficiently developed to allow the plant to synthesize its own food.

Thus, what are commonly called pips (e.g. in apples, tomatoes) are really seeds. So too are a number of the foods we eat (e.g. cereals such as wheat and rice, vegetables such as peas, and nuts such as peanuts).

3. The function of flowers, fruit and seeds

Some flowering plants reproduce vegetatively (that is, a new plant can be produced from a root, stem or even a leaf) but almost all have the capacity to reproduce sexually to ensure their long term self-survival. The flowers, fruit and seeds form the central components in the sexual reproduction process.

(a) The flowers

The whole function of the flower is to produce seeds (Hall, 1974). Pollination is the transporting of pollen from stamen to stigma by animal (usually bee or butterfly), wind or springy mechanisms within the flower itself, depending on the species of flower. Nuclei from pollen grains from the male cells of the flowers (stamen) pass down a pollen tube. They reach the egg cells (ovules) in the ovaries at the base of the carpel and fuse with (i.e. fertilize) the egg cells which then develop into seeds.

(b) The fruit

From a biological point of view, the main function of fruit is to aid seed dispersal (Hall, 1974; Victor, 1975). Dispersal can occur in a number of ways. For example, the seed contained within succulent

fruit can be dispersed by animals which eat the fruit. Other seed has fruit which is transported by wind, water or the fur of creatures to which it becomes hooked, while yet other seed is dispersed by fruit which suddenly bursts open when ripe.

(c) The seeds

The function of seeds is to reproduce the species. Hence dispersal is important to prevent overcrowding and increase the chances of survival (Victor, 1975).

(d) The flowering plant life cycle

The life cycle of flowering plants, when reproduction is by sexual means, can be represented as in Figure 3.

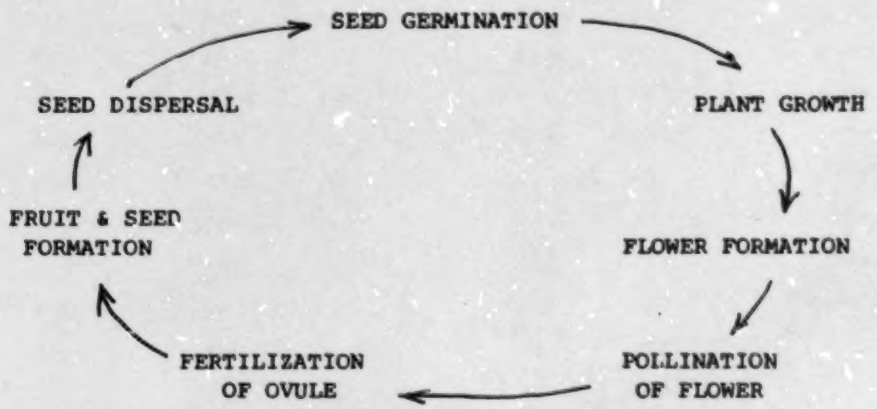

Figure 3: Life cycle of a flowering plant by means of sexual reproduction

RESULTS

A. PUPILS' VIEWS ABOUT THE INSTANCES AND NON-INSTANCES OF FLOWERING PLANTS

The pupils' responses during the interviews to the first set of questions about whether the plants shown in the photographs can have flowers, fruit and seeds are listed in Table 2.

Table 2: Pupils views about whether various plants can have flowers, fruit and seeds (N=80)

		PERCENTAGE OF PUPILS[1]					
		CAN IT HAVE FLOWERS?		CAN IT HAVE FRUIT?		CAN IT HAVE SEEDS?	
	PLANT	YES	NO	YES	NO	YES	NO
1.	Apple tree	60%	38%	100%	0%	94%	6%
2.	Pumpkin	63%	25%	1%	99%	89%	9%
3.	Lemon tree	46%	46%	96%	4%	75%	18%
4.	Grass	9%	89%	0%	100%	29%	65%
5.	Fern[2]	4%	95%	1%	99%	38%	54%
6.	Rose bush	96%	4%	0%	100%	41%	53%
7.	Carrot	5%	95%	4%	95%	25%	70%
8.	Tomato	44%	53%	19%	79%	66%	33%
9.	Mushroom[2]	1%	99%	1%	98%	26%	65%
10.	Gorse	50%	46%	3%	95%	40%	59%
11.	Bean	46%	48%	4%	95%	56%	38%

1 With many of the items a small percentage of pupils were unsure.
2 Non-flowering plants which have no flowers, fruit or seeds.

While the photographs were deliberately chosen not to show flowers, fruit or seeds (see earlier) this did not prevent a small number of children from 'observing' in the photographs some of the features about which they were asked. For example, three children pointed to the prickles on the stem of the rose plant and said that they were the seeds.

Features of the pupils' responses

1. Responses to the question: Can it have flowers?

Inspection of Table 2 reveals that:

(i) most pupils said that the non-instances (fern and mushroom) could not have flowers;

(ii) most pupils considered that two of the instances (grass and carrot) could not have flowers;

(iii) pupils were roughly evenly divided in their views of whether the remaining instances could have flowers.

The usual explanation given by pupils to support their view that various instances could have flowers was that they had seen flowers on them. For example, a 9 year old said that a pumpkin plant could have flowers; "They're yellow. I've seen them in gardens" and an 11 year old said that apple trees can have flowers as she had seen them. She added, "I used to have an apple orchard at my house."

Conversely, the most common explanation given by pupils to support their contention that various instances could not have flowers was that they had never seen them with flowers. For example, a 14 year old said that apple trees could not have flowers. She explained, "We live next to an orchard and I've never seen any flowers on them." Similarly, a 9 year old considered that tomato plants could not have flowers; "We've got tomato plants but I've never seen them with flowers."

In the course of the interviews, 17 pupils used the term 'blossom' with respect to the apple and lemon trees. Of these 17 pupils, only three said that blossoms were not flowers. For example, in response to the question, "Are you thinking that blossom is different from flowers, or the same as flowers?" a 12 year old replied,

> "No, you don't get flowers growing on trees, so I'd say blossom is different."

A few pupils were puzzled as to whether certain plants could have flowers, as indicated by seven questions asked during the interviews and class sessions. The questions included:

Do orange trees grow flowers?	(10 year old)
Does grass have flowers?	(12 year old)
Do carrots have flowers?	(12 year old)

2. Responses to the question: Can it have fruit?

Table 2 shows clearly that most pupils said:

(i) the non-instances (fern and mushroom) could not have fruit,

(ii) the two instances 'apple tree' and 'lemon tree' could have fruit,

(iii) the remaining instances could not have fruit.

By far the most common explanation given by pupils to support their view that the pumpkin, carrot, tomato and bean plants could not have fruit was that they have vegetables. For example, a 7 year old said of the pumpkin plant, "Are pumpkins fruit? I think I call them vegetables. I don't really think they get fruit." Likewise, a 14 year old said of the tomato plant, "They have tomatoes but you wouldn't call them fruit - they're vegetables."

The tomato plant was the one item given more thought by the pupils than any other. For example, a 14 year old reflected, "Sometimes tomatoes are considered fruit [What do you call them?] Vegetables" and a 10 year old pondered,

> "Vegetables come out of the ground but, no it (tomato) come out of the ground didn't it because it was a seed. Ohh no, (a tomato is) a vegetable."

On the other hand, a 9 year old's view of tomatoes was, "They are fruit, but they can be called 'vegetable'." In the end, 19% of the pupils decided that a tomato plant could have fruit.

One other feature of the children's responses to the question about fruit was that half the 7 year olds (five children) said at first that pumpkin, tomato and bean plants could have fruit but then decided that they really called pumpkins, tomatoes and beans 'vegetables'. For example, when asked whether a pumpkin plant could have fruit, one child replied,

> "Yeah, I call them (pumpkins) fruit ... no I don't, I call them vegetables."

A few pupils were puzzled about whether certain plants could have fruit as indicated by four questions asked during the interviews and class sessions. The questions were:

"Is a potato a fruit?" (9 year old)
"Is a strawberry a fruit?" (10 year old)
"Is rhubarb a fruit?" (10 year old)
"I've forgotten about tomatoes, are they vegetables or fruit?" (11 year old)

3. Responses to the question: Can it have seeds?

Table 2 reveals a more complex set of responses to this question than for the previous two. The pupils' responses may be summarised as follows:

(i) approximately one-third and one-quarter of the pupils respectively considered that the two non-instances (fern, mushroom) could have seeds;

(ii) three-quarters or more of the pupils said that the lemon tree, pumpkin plant and apple tree could have seeds;

(iii) between half and two-thirds of the pupils thought that the bean and tomato plants could have seeds;

(iv) between one-quarter and two-fifths of the pupils considered that the carrot plant, grass, rose and gorse bushes could have seeds.

Ten pupils used the term 'pips' when talking about some of the items but in only two cases were these regarded as being different from seeds. For example, when asked whether a tomato plant could have seeds anywhere, a 12 year old said,

> "Tomatoes have got pips inside. (Are you thinking they might be seeds?) No, I don't think so."

Although the results shown in Table 2 represent the pupils' ideas about whether the various plants can have seeds, not all their positive responses to the instances can be taken as indications that the pupils have a useful understanding of these items. For example, of those pupils who claimed that grass (23 pupils), rose (33 pupils) and carrot plants (20 pupils) can have seeds, a majority responded to the interviewer's probe, "I wonder where you would actually find the seeds?" by locating the seeds on the plants in places other than where they would be found naturally (see Table 3).

Table 3: Number of pupils who said that grass, rose and carrot plants can have seeds, but who then located the seeds in unnatural places on the plants.

PLANT	NUMBER OF PUPILS	
Grass	(N=23)	12
Rose	(N=33)	18
Carrot	(N=20)	17

Popular locations for the seeds given by these pupils were:

(i) underground amongst the roots (or in the carrot),

(ii) on or in the leaves or stem.

With respect to the two non-instances of fern and mushroom, which 30 pupils and 21 pupils respectively said could have seeds, the most

commonly expressed locations for the seeds were:

(i) on the leaves (fern - 17 pupils)
(ii) on the top part or head (mushroom - 14 pupils)
(iii) underground (fern - 3 pupils; mushroom - 5 pupils)
(iv) on the stem or stalk (fern - 2 pupils)

An unanticipated response was that given by 13 pupils who said that carrot plants need seeds to 'start off' but do not have seeds when grown.

The explanations given by the pupils to support their views that various plants either could or could not have seeds were more diverse than those offered for flowers and fruit. The explanations offered with respect to various plants having seeds and the number of pupils who gave them, are summarised in Table 4.

Table 4: Number of pupils and explanations given to support their view that various plants can have seeds.

PLANT	BASIS OF EXPLANATIONS AND NUMBER OF PUPILS				
	Have observed seeds	Assumption/ prior idea about regeneration	Use of Analogy	Reference to plant	Just thinks so
1. Apple	44	2	-	4	-
2. Pumpkin	51	1	2	2	2
3. Lemon	39	-	1	-	1
4. Grass	8	10	-	-	-
5. Fern	1	5	-	9	1
6. Rose	3	9	1	3	3
7. Carrot	3	13	1	-	-
8. Tomato	38	5	-	1	-
9. Mushroom	-	4	-	-	-
10. Gorse	2	6	1	1	1
11. Bean	29	4	-	1	-

Table 4 shows that the explanation given most frequently was that the pupils had seen the seeds. This was particularly so with the apple, pumpkin, lemon, tomato and bean plants. For example, a 7 year old said of an apple,

> "When you split an apple in half, in the core are little black seeds."

Another example of a pupil observing seeds was a 12 year old who said that there were grass seeds.

> "In the stalk. I've picked some (stalks) and it's long, and it's got little furry things on it. They look like seeds."

The second category of explanations contained explanations from pupils who had not seen seeds on certain plants but who nevertheless thought the plants could have seeds since:

(i) in their view that is what the plants grew from, or their species survival depended on it, or

(ii) they had other ideas which suggested the plants could have seeds.

Typical examples of the first type of response were:

> [Carrot plant] "They grow off a seed so they must produce it." (13 year old)

> [Gorse seed] "I think so. I can't think of any other way they'd [gorse plants] spread without seeds." (9 year old)

> [Rose seed] "They could be near the flower 'cause if there weren't any seeds there wouldn't be any roses." (7 year old)

Explanations of the second type included:

> [Gorse plants] "Yes (they have seeds). All plants grow from seeds." (13 year old)

> [Carrot seed] "In the carrot or somewhere. (What makes you think they've got seeds?) Oh, because you go in a shop and you can by some seeds." (11 year old)

> [Carrot seed] "In the carrot. (How did you know that?) Because I've aten a carrot before and swallowed the seed." (7 year old)

Pupils in the third category used analogy. For example, a 14 year old said that carrots must have seeds. When asked where the seeds would be he said,

> "Um ... if you just let the carrots sit in the ground and just let the growing leaves go to seed. (How do you know?) I think I just guessed. I've never actually seen them but I've seen lettuce when they get white seeds."

Likewise, when asked how she knew a pumpkin could have seeds, a 7 year old commented,

> "I think you get them in the middle of the pumpkin like paw paw and that sort of stuff."

Pupils in the fourth category who referred to the plant in question did not give an explanation in the usual sense. For example, a 9 year old said that ferns have seeds,

> "On the back of the leaves. (How do you know?) We've got lots of ferns at home."

Similarly, a 13 year old said that tomato plants have seeds,

> "Inside the leaves. (How did you know about this?) Because we've got tomato plants."

The few pupils in the last category simply thought that certain plants could have seeds. For example, an 8 year old said that pumpkin plants have seeds:

> "On the leaves. (How did you know?) I don't know; I think it was just a guess."

and a 12 year old considered that a rose bush could have seeds:

> "Down by the flower. (What makes you think that?) We've got rose bushes at home and I always pick them (the roses) for mum. I haven't really seen them (seeds) but I think there are some there."

Whether certain plants could have seeds was something that puzzled a number of pupils as indicated by 18 of the questions asked during the interviews and class sessions. Typical questions were:

Does a tree have seeds? (7 year old)
Does a radish have seeds? (9 year old)
Has gorse got seeds on them? (12 year old)
Does the carrot have seeds? (12 year old)

B. PUPILS' VIEWS ABOUT THE FUNCTION OF FLOWERS, FRUIT AND SEEDS

1. Pupils' ideas about the function of flowers

The pupils' responses when asked why they thought various plants had flowers are summarised in Table 5.

Table 5: Pupils' responses about why various plants have flowers

	RESPONSE	NUMBER OF PUPILS 7-8 yr	9-10 yr	11-12 yr	13-14 yr	Total	%
1.	Don't know, not sure	9	8	7	7	31	39%
2.	To form fruit or vegetables	4	5	6	6	21	26%
3.	They grow that way	3	3	3	2	11	14%
4.	To make seeds	1	3	1	1	6	8%
5.	Others	3	1	3	4	11	13%
						80	

Table 7 shows that only 8% of the pupils interviewed gave a reason which reflected the biological view, namely that the function of flowers is to produce seeds. Even then a number of their responses were tentative. For example, a 7 year old said,

"I think because it's got the seed inside the flower."

and a 10 year old replied,

> "Maybe they've got flowers because that's where their seeds are to grow."

Twenty-six percent of the pupils gave a reason which related to the growth of fruit or vegetable. For example, a 9 year old said,

> "'Cause the flower forms into a fruit."

and the reason given by a 14 year old was,

> "I think because all the fruit and veges and that can grow in the spot where the flowers grow."

A further 14% of the pupils indicated that they thought various plants have flowers because that's just the way the plant grows. For example, a 10 year old said,

> "It might be just the way they're made."

and a 13 year old responded,

> "Perhaps it's the way they grow; it's their nature to have flowers I guess."

Another group of pupils (39%) indicated that they did not know or were not sure why various plants have flowers. For example an 8 year old said, "... mm ... I don't know." and a 13 year old replied, "I don't know really."

A variety of other reasons was given by 13% of the pupils for why various plants have flowers. They included:

(i) because it is spring time,
(ii) to provide pollen or nectar for bees,
(iii) to make the plant look nice, and
(iv) to show where the fruit will be.

The supplementary question, "Would the flowers be of any use to these things you said they were on?" was put to 33 pupils whom the interviewer thought may not have understood the original question. The responses of these pupils suggests that they had no further knowledge to draw on.

The results of the survey of pupils' ideas about the function of flowers are shown in Table 6.

Table 6: Prevalence of views of 7-12 year olds with respect to function of flowers

FLOWERS: The main reason a plant has flowers is:	PERCENTAGE OF PUPILS 7-8 yr (N=74)	9-10 yr (N=173)	11-12 yr (N=104)	Total (N=351)
1. Because it just grows that way.	1%	6%	1%	3%
2. To grow seeds.	5%	13%	33%	17%
3. To make it look nice.	15%	7%	5%	8%
4. To grow fruit.	4%	6%	15%	9%
5. Because bees need the pollen and nectar.	50%	47%	31%	43%
6. To show where the fruit will be formed.	7%	9%	7%	8%
7. Because it is spring time.	11%	5%	3%	5%
8. I don't really know why it has flowers.	7%	11%	5%	8%
9. I have never thought about it before.	12%	17%	13%	15%

Apart from showing that different choices were prevalent at each age level, and that a minority of pupils either did not know why certain plants have flowers or hadn't thought about it before, Table 6 also shows several trends with age: the older the pupil, the greater the percentage who chose that the main function of flowers is to produce seeds, and the smaller the percentage who chose that the main reason plants have flowers is to make them look nice or because bees need the pollen or nectar. However, even with the able 11-12 year olds, two-thirds did not choose the scientific view.

Questions asked by the children about flowers and their function - almost all were asked in the classroom situations - indicate considerable curiosity on the part of pupils about this. Their questions included:

* Why do plants have flowers?
* Why does the flower come and then the fruit?
* How do the flowers get on the tree?
* Why do tomatoes have flowers on it?
* How does a flower turn into a pumpkin?
* Do we need flowers?
* Why do weeds have flowers?
* What is a flower?
* Why do flowers have pollen in them?
* Do bees do anything to the flowers?
* Do all flowers attract bees?
* Why do different flowers have different colours?
* What do blossoms do for the fruit?
* What kind of parts does a flower have?
* Why do flowers have a smell?
* Are any flowers used as drugs and chemicals?

2. Pupils' ideas about the function of fruit

The pupils' responses in the interviews when asked why they thought various plants had fruit are summarised in Table 7.

Table 7: Pupils' responses about why various plants have fruit

RESPONSE	NUMBER OF PUPILS 7-8 yr	9-10 yr	11-12 yr	13-14 yr	Total	%
1. Don't know, not sure	9	9	10	9	37	46%
2. Just grows that way	5	4	7	6	22	28%
3. For us to eat	4	2	2	3	11	14%
4. Have seed for new plant	1	3	0	0	4	5%
5. Other	1	2	1	2	6	7%

In response to this initial question, none of the 80 pupils interviewed expressed the idea that fruit functions as a seed dispersal mechanism, although four did mention that fruit contains seeds for a new plant. For example, one 10 year old responded:

> "Some of them have seeds; like the apple, if you put them in (the ground) they start growing."

Forty-six percent of the pupils indicated that they did not know or were not sure why various plants have fruit. Typical responses were:

> "Ahh ... I don't know." (9 year old)
>
> "I don't know; I haven't thought about that one." (11 year old)
>
> "I don't really know." (13 year old)

Another reason, given by 28% of the pupils, is that plants just grow that way, for example,

> "'Cause it grows on it and it knows the plant it's on." (7 year old)
>
> "The main reasons the apple (tree) should have fruit on is because it's an apple tree." (13 year old)

A further reason, given by 14% of the pupils, is that plants have fruit for us to eat, for example,

> "Maybe it's so we can get quite a lot of fruit, and fruit has got this kind of thing in it that helps us grow and run round." (7 year old)
>
> "I don't know; it grows there for people to eat I suppose." (14 year old)

Other reasons, given by the remaining 7% of pupils, were not reasons in the usual sense. For example, a 10 year old responded,

> "Well, fruit is sweeter than vegetables."

Since the initial question about the function of fruit seemed to present difficulties for many of the pupils, the supplementary question, "Would the fruit be of any use to these things you said they were on?" was put to 50 of them.

Their responses to the supplementary question showed that one 7 year old had an idea that fruit is involved in seed dispersal, that 11 pupils knew that fruit contains seeds for new plants, but that the majority of pupils had no further knowledge to draw on.

The results of the survey of pupils' ideas about the function of fruit are shown in Table 8.

Table 8: Prevalence of views of 7-12 year olds with respect to function of fruit

FRUIT: The main reason a plant has fruit is:	PERCENTAGE OF PUPILS 7-8 yr (N=74)	9-10 yr (N=173)	11-12 yr (N=104)	Total (N=351)
1. Because it just grows that way.	8%	8%	3%	7%
2. To make it look nice.	4%	0%	2%	1%
3. For us to eat.	43%	54%	13%	39%
4. So the seeds can be spread around.	23%	23%	72%	38%
5. To help the plant grow.	16%	9%	3%	9%
6. I don't really know why it has fruit.	7%	13%	3%	9%
7. I have never thought about it before.	12%	18%	13%	15%

Apart from showing that a relatively small percentage of pupils indicated that they did not know why a plant has fruit, or had not thought about it previously, Table 8 shows that most pupils chose that the reason plants have fruit would be either 'for us to eat' or 'so the seeds can be spread around'. There was also an age difference with these responses, the older pupils (11-12 years) preferring the latter option over the former, and the younger pupils (7-10 years) having the reverse preference.

The questions asked by pupils - again almost wholly within the class situations - indicated that fruit was also something which interested

them. Their questions on this aspect of flowering plants included:

* How does the tree make fruit?
* What's the fruit made of?
* How come some fruits come at different times to others?
* What do blossoms do for the fruit?
* How do the apples grow, and how do the seeds get in there?
* Why do fruit have seeds?
* Does the fruit which falls onto the ground sort of become compost and help the seed inside to grow?
* How come the fruit needs blossom before it can develop?
* Why are fruit round?
* How do tomatoes grow?

3. Pupils' ideas about the function of seeds

The pupils' responses in the interviews when asked why they thought various plants had seeds are summarised in Table 9.

Table 9: Pupils' responses about why various plants have seeds

RESPONSE	NUMBER OF PUPILS 7-8 yr	9-10 yr	11-12 yr	13-14 yr	Total	%
1. That's what they grow from, or to grow more plants of the same kind.	11	19	19	20	69	86%
2. Store food for the plant.	2	0	0	0	2	3%
3. Don't know	4	1	0	0	5	6%
4. Other reasons	3	0	1	0	4	5%

The majority of pupils interviewed were quite clear that plants have seeds because that is what they grow from or they are needed to regenerate the species, for example,

"They just drop off and create new plants."
(11 year old)

"Just reproduce themselves; that's probably why they have seeds." (13 year old)

"That's so you can grow them. (How do you mean, grow them?) Grow some more trees." (7 year old)

The two younger pupils who said that the seeds store food for the plant were both from a class where the children had planted bean seeds in containers and had the bean plants growing up support sticks. They appeared to have the idea that the seeds which develop on the plants have a store of food for the plants, rather than containing a food supply to enable the baby plants to begin growth. For example, one of the children said that plants have seeds,

"'Cause they probably put food in the seed and keep it there. (Why would they do that, I wonder?) So when there's no food, they (the plants) could just take, could just you know ..."

When the 14% of pupils who did not say initially that plants have seeds to reproduce themselves were asked what would happen if an apple seed (or whatever seed they had mentioned themselves) were put in the ground, they all indicated that it would grow up into a plant of the kind from which it came.

The results of the survey of pupils' ideas about the function of seeds are shown in Table 10.

Table 10 shows that a minority of pupils did not know why plants have seeds, or had not thought about it previously. It also shows that a majority (almost all the pupils by age 11-12 years) chose that the seeds are to grow new plants of the same kind. The percentage of pupils who chose reasons 1 and 4 ('Because it grows that way' and 'For us to eat') declined with increasing age.

Table 10: Prevalence of views of 7-12 year olds with respect to function of seeds

SEEDS: The main reason a plant has seeds is:	PERCENTAGE OF PUPILS 7-8 yr (N=74)	9-10 yr (N=173)	11-12 yr (N=104)	Total (N=351)
1. Because it just grows that way.	20%	7%	1%	8%
2. To grow new plants of the same kind.	57%	84%	92%	81%
3. To have a store of food for itself.	5%	5%	5%	5%
4. For us to eat.	8%	2%	0%	3%
5. I don't really know why it has seeds.	9%	10%	2%	7%
6. I have never thought about it before.	14%	13%	14%	14%

C. PUPILS' VIEWS ABOUT THE REPRODUCTION OF CERTAIN PLANTS

As can be seen from Table 2, 71% of the pupils interviewed thought that grass can not have seeds, and 75% thought that carrot plants can not have seeds. During the interview, the opportunity was taken to obtain the views of a number of these pupils about how new plants of these types could be grown. The form of questioning was: "You said that grass (or carrots) does not have seeds. I'm wondering how you could grow new grass (or carrots) if you wanted to." The pupils' responses are summarised in Tables 11 and 12.

Table 11: The ideas of 28 pupils about how new grass can be grown

REASON	NUMBER OF PUPILS 7-8 yr	9-10 yr	11-12 yr	13-14 yr	Total
1. It must have seeds somewhere.	0	1	4	5	10
2. Buy some seeds					
- origin unknown	2	2	2	0	) 7
- which are made	0	0	0	1	)
3. It just grows					
- spontaneously	1	1	0	2	) 6
- from existing grass	0	1	0	1	)
4. Don't know	0	1	1	3	5
					28

Table 12: The ideas of 42 pupils about how new carrots can be grown

REASON	NUMBER OF PUPILS 7-8 yr	9-10 yr	11-12 yr	13-14 yr	Total
1. It must have seeds somewhere.	0	2	2	4	8
2. Buy some seeds					
- origin unknown	3	5	3	5	) 22
- which are made	2	3	1	0	)
3. It just grows	1	0	0	0	1
4. From the carrot top	0	4	2	1	7
5. Don't know	0	0	1	3	4
					42

Tables 11 and 12 show that a majority of pupils decided that either grass and carrot plants must have seeds after all, for example,

> [Carrot plants] "Must have seeds. (Why do you say that?) Well, if you buy carrot seeds in a shop ... I've never taken the top off a carrot and put it back in the ground and waited for it to grow. I could always try it but I doubt that you'd get anything out of it, so they must have seeds." (13 year old)

or seeds must be bought to grow new plants of these two species, for example,

> [Grass seed] "You could get it from the shop in a wee packet or ... I don't know where the shop people would get the seeds." (9 year old)

An unexpected idea expressed by seven pupils was that seed (more particularly carrot seed) bought from a shop has somehow been made or manufactured by people rather than grown by a carrot plant or grass. For example, when asked,

> "I wonder where the people in shops get carrot seeds from?"

a 9 year old replied,

> "They (people) could make them."

and a 13 year old answered a similar question about grass seed,

> "They (shopkeepers) probably get it from a um, factory or something like that that makes seeds."

A 10 year old went further and expressed a tentative view of what people might make carrot seeds out of:

> "They (people) might have a special sort of powder or stuff, mixture or liquid or something that you can put into them (seeds), and when water touches them it might make them grow an inch or something."

Seven of the 9-14 year old pupils said that new carrot plants could be obtained by planting the tops of carrots. For example, a 10 year old said,

> "Ohh, cut off the top with the green things on it and plant that with a bit of water."

Another idea which was a little unexpected was that expressed by six pupils that grass in particular regenerates spontaneously. For example, in commenting on how it would be possible to grow new grass, a 13 year old said,

> "Oh, that just comes naturally; it comes naturally in the ground really. We've got grass all over the place and we have to keep mowing it but if you try to cut it down it will just grow up again. I've taken some grass out of the ground and about a week later there was grass coming up, so it obviously grows naturally out of the ground."

At the end of the interviews when the pupils were invited to ask questions about anything they wanted to know or anything that was puzzling them only five asked about the function of seeds or plant regeneration. Their questions included:

* Where do they get the carrot seeds, because I don't really know if they have seeds in, carrots? (10 year old)
* [Grass] Where does it get the seeds? (13 year old)
* I want to know if you can get pips out of the rose and then grow them again? (13 year old)
* Gorse and that sort of stuff just grows by itself doesn't it; you don't plant that stuff do you? (13 year old)
* How do carrots grow? (14 year old)

Other questions about seeds asked by pupils in the class situations included:

* Why are there seeds in most fruit or vegetables?
* How did the seeds get in the fruit?
* How do little seeds turn into big fruit?
* How does a seed produce a plant?
* What's seeds made of?
* Can the seeds in each thing grow into the plant?
* How do seeds grow?
* How do the seeds get into the plants?

D. OTHER IDEAS EXPRESSED BY PUPILS INTERVIEWED

1. All plants have seeds

Eight pupils (spread across the age range) held the view that all plants have seeds since this is their means of reproduction. This led them to say, of course, that the fern and mushroom could have seeds. One 10 year old, for example, when asked whether the mushroom could have seeds said,

> "They must have seeds somewhere. Yeah they would have seeds, otherwise they wouldn't be able to grow again in the wild and things."

2. Seeds grow up with the plant and/or make the flower

Five pupils expressed the idea that seeds grow up with or through the plant and/or grow to form the flower. Instances of the former idea were:

> "The seeds might be in the ground and when it (the plant) grows, the seeds might just grow through the plants and grow out at the top, 'cause sunflower seeds grow up, um ..." (7 year old)

> "The seeds grow right up the stalk and make the veges come out, the fruit; is it fruit?" (13 year old)

Instances of the latter idea were:

> "The seed goes into a bud and that becomes a rose (flower)." (12 year old)

> "The seeds are in the stalk, so there are a whole lot up the stalk make the flowers come out into bud." (13 year old)

E. FURTHER FEATURES OF THE PUPILS' RESPONSES IN THE INTERVIEWS

1. Few pupils made a connection between flowers, fruit and seeds

As tables 7 and 8 show, 23 pupils made a connection between flowers and fruit (or vegetables), and six pupils made a connection between flowers and seeds. Tables 10 and 11 show that 15 pupils made a connection between fruit and seeds. However, only seven pupils made a connection between flowers, fruit and seeds. (Three of the pupils were at the 7-8

year level, three at the 9-10 year level, and one at the 11 year level.) The following excerpt from an interview with an 8 year old shows the kind of connection that four of these seven children tended to make.

Interviewer: Why do some of these plants have flowers?

Child: So that they can have fruit afterwards or vegetables.

Interviewer: So the flower's got something to do with the fruit.

Child: Yes.

Interviewer: What happens there?

Child: Because, like an apple tree, a bee comes along and pollinates the flower and it turns into an apple, and the flower petals drop off.

Interviewer: What about the pumpkin, does the same happen there or is that different?

Child: Um, it's a bit different because some (flowers) don't develop (into pumpkins) but others do.

[Note: If pollinated, female flowers develop into pumpkins; male flowers do not.]

Interviewer: [Later] And is the fruit any use to the plants?

Child: Yes, because it's got the seeds inside.

Interviewer: Why do some of these plants have seeds?

Child: So that there can be more of them (i.e. more plants of the same kind).

The remaining three pupils made a similar connection but either had a more restricted view, or included an additional idea that would not be helpful to an understanding of the flowering plant life cycle. For example, a 10 year old expressed a connection very similar to that quoted with respect to fruit (the apple and lemon) but did not think that it applied to 'vegetables' (pumpkin and bean). An example of a potentially unhelpful additional idea being expressed was that of a 7 year old who said that the seeds on the tree have food in them to make the tree grow.

2. Only a minority of pupils asked questions

The number of pupils who asked questions when given the opportunity at the end of the interviews is listed in Table 13.

Table 13: Number of pupils who asked questions at the conclusion of the interviews

7-8 yr	9-10 yr	11-12 yr	13-14 yr	Total
5	4	6	3	18

Table 13 shows that less than one-quarter of the 80 pupils interviewed asked questions when invited to do so. This surprised the interviewer to some extent, given the relatively large number of pupils who said that they did not know, or were not sure, why various plants can have flowers or fruit, or how new carrot plants or grass can be grown (see tables 5, 7, 9, 11 and 12).

The following response of a 12 year old was typical of a number of pupils who might have been expected to ask a question but who did not.

Interviewer: Would seeds be any use to the plant at all?

Pupil: Yeah, they're the ones that make the plant grow, seeds, I think.

Interviewer: What about grass then?

(The pupil had said previously that grass did not have seeds.)

Pupil: I wonder how that grows. It must ... can't just appear, probably with seeds or something. I don't know.

Interviewer: Now, are there any questions you'd like to ask; is there anything that's puzzling you?

Pupil: No, I can't think of anything.

3. A number of the pupils' ideas were expressed tentatively or formed during the interview

Apart from those pupils who said that they did not know or were not sure, particularly with respect to the function of flowers and fruit, 20 other pupils expressed ideas in a rather tentative manner and/or indicated that they had constructed them during the interview. The following responses are illustrative of this:

(i) A tentative response

Interviewer: You think the flower actually develops into fruit. Is that what you're saying?

Pupil (10 yr): Um ... well it might. I don't really, um ... yes it might just develop into the actual fruit, or ...

(ii) A constructed response

Interviewer: How do you mean, the flowers bloom and start off the apple?

Pupil (14 yr): Well um, to grow buds and the apples come there.

Interviewer: Yes, what are you saying, the flower makes the buds grow, or does the bud turn into an apple, or ? I've got an idea what you're saying but I'm not quite sure I've got the right idea.

Pupil: No, I don't know myself (laughs). I know that they do bloom though.

(iii) Another constructed response

Interviewer: How would you get more carrots to grow if you wanted them?

Pupil: (also 14 yr) Just get some carrot seeds.

Interviewer: I though you said carrots didn't have any seeds.

Pupil: Well, um (chuckles) they must be somewhere on it; there must be some there anyway. I've never really thought about it before. When you ask me these questions I just try to think of something that they do. I don't really know if they do or not.

In addition to the 20 pupils just mentioned, another six at the 7-8 year level also showed how pupils constructed ideas during the interviews when they said that they had not seen a pumpkin plant (and questioning revealed that they had no other basis for knowing) but then stated that pumpkin plants either do or do not have flowers. When asked how they knew, the pupils tended to say that they just knew.

DISCUSSION AND IMPLICATIONS FOR TEACHING

1. Meanings for certain words

It became evident during the interviews that a number of pupils had a restricted meaning for several words; three pupils did not consider that flowers included blossom, two did not think that seeds included pips, and many did not consider that fruit included such vegetables as pumpkins, tomatoes and beans.

The meaning of the three terms 'flowers', 'seeds' and 'fruit' would need to be clarified with pupils early in a teaching sequence on the topic of flowering plants. The inclination of some of the younger children to initially call the vegetables just mentioned 'fruit' suggests that the task of clarifying the meanings of the terms with the pupils may be relatively simple.

2. Perceived relationship between flowers, fruit and seeds

The fact that only four pupils of the 80 interviewed had a general idea of the flowering plant life cycle which was similar to that of biologists indicates that 'flowering plants' is a topic with considerable scope for teaching.

3. Propensity to try to make sense of phenomena

Data from the three sources (interviews, survey and classrooms) suggest that many of the pupils were actively making an attempt to understand the

phenomena of flowering plants. During the interviews, for instance, pupils drew on their past experiences (e.g. whether they thought they had seen flowers, fruit or seeds on various plants), on their present ideas (e.g. all plants grow from seeds) and on analogy (e.g. knowledge of how lettuce plants and paw paws produce seeds) to fashion explanations and reasons. Some of the explanations and reasons given were very sensible ones (e.g. the function of seeds is to regenerate the species) but others would not be helpful to an understanding of the flowering plant life cycle (e.g. some plants are grown from seeds but do not produce seeds themselves).

Compared with the interview data, the survey results suggest that the pupils who were surveyed made use of the alternative reasons offered to help them make sense of the function of flowers, fruit and seeds. Whereas 39% of the pupils interviewed said that they did not know or were not sure why plants have flowers, and 46% said the same about fruit, the comparable percentages for the pupils surveyed were 8% and 9% respectively. In other words, the pupils who were surveyed tended to accept the invitation to choose one of the options listed and not indicate that perhaps they didn't really know.

Finally, the questions asked by the pupils both at the end of the interviews and during the class sessions suggest that a number of pupils would like to be able to make sense of the phenomenon of flowering plants.

The implications for teaching that may be drawn from the pupils' responses are as follows:

(i) Since pupils made use of past experiences, but did not usually generalise from an experience with a single plant, they should be provided with opportunities to experience several plants in the flower, fruit and seed stages. (The whole three stages may be found on some plants at the same time.)

(ii) Since pupils do not necessarily hold either any ideas, or useful ideas, about flowering plants at present, but seem willing to consider various alternatives, exposure to a range of views to help them interpret their experiences would seem desirable.

(iii) Many of the questions asked by pupils about flowering plants, especially in the class situations, would provide the basis for building worthwhile understanding of the topic. It would therefore seem advantageous to give pupils the opportunity to carry out meaningful investigations based on some of their questions.

CONCLUSION

Although there are references to flowering plants in the content of the Infant-Standard 4 Syllabus and Guide (Department of Education, 1978) and in various Resource Units, and although Topic 3 (plant propagation) of the present School Certificate horticulture prescription (Department of Education, 1984) assumes that pupils entering that course will understand the flowering plant life cycle, few of the pupils interviewed displayed such understanding.

Taken together, the results of this investigation would seem to confirm the need to make the flowering plant life cycle itself the focus of a study for pupils.

REFERENCES

1. Bell, B. Animal, plant, living : notes for teachers. LISP Working Paper No. 30. Hamilton, N.Z. S.E.R.U., University of Waikato, 1981.

2. Hall, J.R. Biology. N.Y. : David McKay, 1974.

3. Harlen, W. and Osborne, R. Toward a teaching model for primary science. LISP(P) Working Paper No. 114. Hamilton, N.Z. S.E.R.U., University of Waikato, 1983.

4. Mavor, J.W. and Manner, H.W. General Biology. N.Y. : Macmillan, 1966.

5. N.Z. Department of Education. Infant-Standard 4 Syllabus and Guide. Wellington, 1978.

6. N.Z. Department of Education. New Zealand Education Gazette, 1984, 63, 4, 85-87.

7. Victor, E. Science for the elementary school. N.Y. : Macmillan, 1975.

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APPENDIX A: Photograph used to clarify the meaning of 'flower'

(Coloured flowers)

APPENDIX B: Photographs depicting instances and non-instances of flowering plants

Apple

Pumpkin

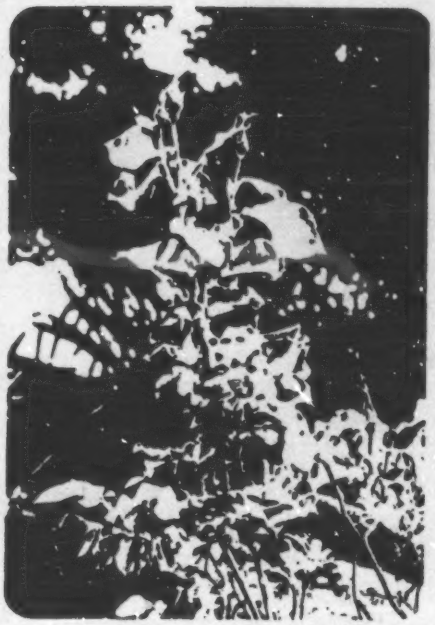
Lemon

Grass

Carrots

Tomato

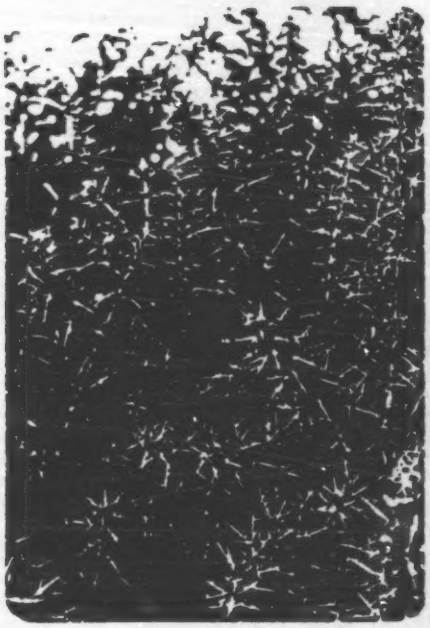
Appendix B continued:



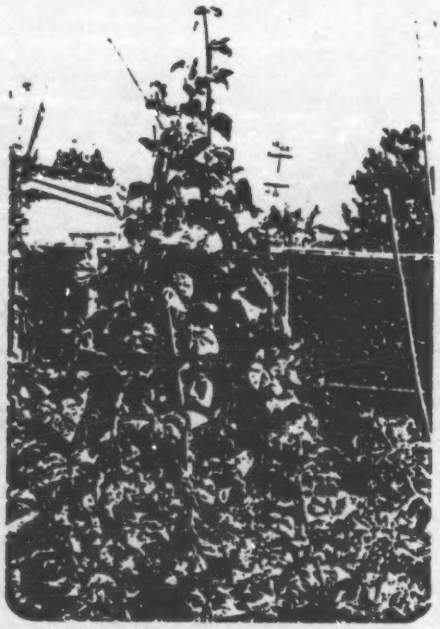
Rose

Fern

Mushroom



Gorse



Bean

APPENDIX C: Record form

NAME: ..... AGE: ..... CLASS: .....

SCHOOL: .....

CAN IT HAVE ...

	FLOWERS ?	FRUIT ?	SEEDS ?
Apple tree			
Pumpkin			
Lemon tree			
Grass			
Fern			
Rose bush			
Carrot			
Tomato			
Mushroom			
Gorse			
Bean			

APPENDIX D

SURVEY ON

FUNCTION OF SEEDS, FRUIT, FLOWERS

NAME: _____

AGE: _____

SCHOOL: _____

SEEDS: The main reason a plant has seeds is:

(1) Because it just grows that way. ☐
(2) To grow new plants of the same kind. ☐
(3) To have a store of food for itself. ☐
(4) For us to eat. ☐
(5) I don't really know why it has seeds. ☐
(6) I have never thought about it before. ☐

FRUIT: The main reason a plant has fruit is:

(1) Because it just grows that way. ☐
(2) To make it look nice. ☐
(3) For us to eat. ☐
(4) So the seeds can be spread around. ☐
(5) To help the plant grow. ☐
(6) I don't really know why it has fruit. ☐
(7) I have never thought about it before. ☐

FLOWERS: The main reason a plant has flowers is:

(1) Because it just grows that way. ☐
(2) To grow seeds. ☐
(3) To make it look nice. ☐
(4) To grow fruit. ☐
(5) Because bees need the pollen and nectar. ☐
(6) To show where the fruit will be formed. ☐
(7) Because it is spring time. ☐
(8) I don't really know why it has flowers. ☐
(9) I have never thought about it before. ☐

APPENDIX E

INITIATING EXPERIENCES USED TO ELICIT PUPILS' QUESTIONS ABOUT FLOWERING PLANTS

Two different sets of initiating experiences were used as follows:

(i) One class of 9 year olds and one class of 10 year olds were taken outside their classrooms to view roses growing in the school garden, other flowers growing in the school gardens, and flowers growing on the lawns.

(ii) One class of 8-9 year olds and one class of 9-10 year olds were shown an apple, pumpkin and tomato, and a blackboard chart was constructed showing that each of these plants at some stage grew flowers, fruit and seeds. Cards containing the words 'plant', 'flower', 'fruit' and 'seed' were placed in random order along the blackboard ledge and the researcher mused whether there was any connection between them and if there was, what their order should be.

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